U.S. Environmental Protection Agency

Nutrient Criteria
Technical Guidance Manual

Estuarine and Coastal Marine Waters

October 2001

Disclaimer

This manual provides technical guidance to States, Indian Tribes, and other authorized jurisdictions to establish water quality criteria and standards under the Clean Water Act (CWA), to protect aquatic life from acute and chronic effects of nutrient overenrichment. Under the CWA, States and Indian Tribes are to establish water quality criteria to protect designated uses. State and Indian Tribal decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance when appropriate and scientifically defensible. Although this manual constitutes EPA's scientific recommendations regarding ambient concentrations of nutrients that protect resource quality and aquatic life, it does not substitute for the CWA or EPA's regulations; nor is it a regulation itself. Thus, it cannot impose legally binding requirements on EPA, States, Indian Tribes, or the regulated community, and might not apply to a particular situation or circumstance. EPA may change this guidance in the future.

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Estuaries and coastal waters are a diverse suite of ecosystems, and differences in methods and approaches are to be expected. This and subsequent manuals are not intended to be singular, one-time publications. As experience accumulates, future editions will be prepared to reflect new understanding.

FOREWORD

This manual is intended for State/Tribal and Federal agency personnel actively engaged in water resource management data collection, assessment, planning, and project implementation. Consequently, it incorporates both a scientific rationale and enough of the "nuts and bolts" of nutrient criteria development and management to help both initiates and those experienced in water resource management.

These nutrient criteria development and management efforts are directed at anthropogenic sources. Inherent "natural" background levels are not and should not be subject to management. Our responsibility is to abate human-caused eutrophication in estuaries and coastal or "near coastal" (out to about 20 nautical miles) marine waters.

To distinguish between natural background enrichment and human impacts, it is necessary to identify localities that experience minimal human influence. Ambient nutrient measurements at these sites may then be compared to similar sites that do experience human influences. The difference in nutrient measurements is the difference between a reference site and a test site. A reference condition is a collection of measurements from several reference sites that incorporates a central tendency statistic.

Because of differences in geologic parent material, climate, and geography, reference conditions are different from one region to another. Similarly, waterbodies, especially estuaries, often respond differently to nutrient inputs. Lakes and reservoirs are different from streams and rivers, and estuaries and coastal marine waters have characteristics different from both. Criteria have to be designed for particular waterbody types and the regions in which they lie.

The primary variables of concern in criteria development are two causal enrichment variables: total phosphorus (TP) and total nitrogen (TN). These nutrients are essential to algal and plant production and are the base of the food chain that supports all other life in the system. Also, two initial response variables usually are the first indicators of biological growth reaction to enrichment. One is chlorophyll *a*, which indicates photosynthesis and biomass production; the other is Secchi depth, a measure of water clarity or a measure of turbidity, reflecting planktonic growth in the absence of inorganic suspended material. In many marine and estuarine instances dissolved oxygen concentration (DO) and macrophyte growth and density are also important measures and, where indicated, may be included as initial response variables. Other measures can also be used, but these have been selected by EPA as of primary concern.

Nutrient criteria consist of judicious incorporation of present **reference condition information** about the primary variables, together with a **knowledge of historical conditions** and trends in the nutrient quality of the resource. These two factors, possibly augmented by **data extrapolations or models**, are analyzed objectively by a **panel of regional specialists** well versed in the biology, physics, and chemistry of the systems of concern. The criteria are also evaluated with respect to the **possible consequences of their implementation on downstream receiving waters**. All of these elements are required for the development of a nutrient criterion.

With this information, the status of a given water resource can be determined, management plans can be made, and management efforts can be evaluated.

The best possible understanding of the physical, chemical, and biological interrelationships in the environment is important in nutrient criteria development and the subsequent management response. However, effective nutrient criteria can and should be developed even in the absence of an in-depth scientific investigation of the ecological processing of nutrients in the estuarine and marine environment. An adequate number of proximal reference sites and current knowledge of the system are sufficient to initiate criteria development and proposed management responses. A conservative, environmentally responsible start can be made toward alleviating nutrient pollution, subject to adjustment as more scientific knowledge is obtained and verified.

The reference condition approach to criteria development was peer reviewed by the USEPA Science Advisory Board in 1990 and 1994 and judged to be scientifically defensible. It is also likely to be the most cost-effective approach.

EXECUTIVE SUMMARY

This manual is designed for use by State, Tribal, and Federal water resource managers as they address the cultural enrichment of their waters in conjunction with the EPA National Nutrient Criteria Program. It is intended to provide a stepwise sequence of actions leading to the development of nutrient criteria for estuarine and near-coastal marine waters to be used in correcting this overenrichment problem.

The premise of the National Nutrient Criteria Program is that many, if not most, of our nation's estuarine and coastal waters are moderately to severely polluted by excessive nutrients (Bricker et al.1999), especially nitrogen and phosphorus. This nutrient pollution affects not only the biotic integrity of the waters and the decline of valuable fish and shellfish, it has the potential to cause harm to the public health through hazardous algal blooms and the propagation of waterborne diseases. To address this problem, EPA uses a regionalized, waterbody type specific approach to the development of nutrient criteria or benchmarks for management decisionmaking. These criteria are based on the measurement of the most natural (or least impacted by human development) waters of a given type in a given area reflecting the condition to be expected in that region if human impacts are not a factor or are at least minimized. The variables of specific concern are total phosphorus and total nitrogen as causal variables, algal biomass (e.g., chlorophyll *a* for phytoplankton and ash-free dry weight for macroalgae), and water clarity (e.g., Secchi depth) as early response variables. In waters that already experience hypoxia, dissolved oxygen should be added as a response variable. EPA encourages States and Tribes to consider additional response indicators such as seagrasses and algal species composition.

This natural ambient background or "reference condition" is an important element of the nutrient criteria to be developed. The other elements are: an understanding of the historical status and trend of the water resource to help put the reference condition in perspective; models of the nutrient data to help better understand historical and present information and to project future consequences; concern and attention to the effects of any criteria development on downstream receiving waters; and the objective compilation and assessment of all of this information by a skilled body of regional experts...the "Regional Technical Assistance Group" or RTAG. The regional criteria so developed are guidelines the States and Tribes of the continental United States can use as they prepare their own criteria and standards for the improvement and protection of the nation's coastal waters.

The first of the actions needed to reach this criteria objective is the organization and utilization in each EPA Region of an RTAG consisting of specialists from State and Federal natural resource management agencies versed in the management and scientific principles most appropriate to that region and those waters. These are water resource managers, oceanographers, chemists, land use specialists, biologists, estuarine ecologists, statisticians, and similar local civil service experts employed by the State or Federal government. Academicians, special interest groups, and environmental group representatives are also important participants in the criteria development process and may assist the RTAG in its efforts.

The first requirement of the RTAG is the review and refinement of ecoregional determinations as most appropriate to the area. These are the geographic boundaries surrounding the similar estuarine and

coastal marine waters for which the criteria will apply. They are based on the EPA Ecoregion concept and incorporate attendant coastal Provinces, both of which are based on geographic and geologic similarities of landforms and parent material. The importance of this regionalization is the effort to deal with waters all having a similar inherent background nutrient loading and response characteristic. Once the regional boundaries and perhaps subregional divisions are completed, the RTAG investigates the physical classification of the waters into similar estuaries or coastal reaches or embayments for criteria development. In many instances the estuaries may be unique and require specific criteria.

Within the classification scheme developed, reference sites are identified as those areas suffering the least cultural development or impact, and the compilation of similar reference sites becomes a reference condition. The manual describes the scientific rationale for the variables selected, the dynamics of the receiving waters, and potentially confounding physical and chemical interrelationships influencing criteria development. It also describes sampling and analytical techniques for data gathering and processing to develop the reference conditions as well as several options for the compiling of this information. These include: (1) recognition and measurement of an excellent water body of ideal nutrient water quality with the aim of preserving this state; (2) in situ reference site determinations for moderately degraded waters; (3) hind casting for historical information from past higher nutrient quality conditions to determine the reference condition when no reference sites remain; (4) use of loading estimations from reference quality subestuarine tributary systems and projection to the estuary; and (5) options for establishing coastal nutrient reference conditions including a Nutrient Criteria Program pilot demonstration project.

Once the reference condition(s) has been determined, the RTAG then addresses the historical perspective; considers the need for models to project future consequences; considers the potential effect on receiving waters; and employs its own good judgment in collectively determining the appropriate criteria values for each of the variables to protect the waters of concern and their designated uses. A procedure is also suggested to equate the multiple criteria variables in a comprehensive dimensionless index score. The manual concludes with a chapter on model development and applications to the criteria program, and a chapter describing the application and implementation of nutrient criteria with emphasis on EPA Standards and Monitoring Divisions and a description of a comprehensive ten step sequential technique for water resource management.

This comprehensive progression from data collection to reference condition determination to criteria development and management responses, is intended to help users achieve the restoration and protection of the nutrient water quality of the nation’s estuarine and near-coastal marine water resources.